Official publication of Pakistan Phytopathological Society
Pakistan Journal of Phytopathology
ISSN: 1019-763X (Print), 2305-0284 (Online)
http://www.pakps.com

SCREENING OF WHEAT COMMERCIAL VARIETIES FOR RESISTANCE AGAINST POWDERY MILDEW (*BLUMERIA GRAMINIS* F. SP. *TRITICI*) AT KAGHAN VALLEY, PAKISTAN

Shahzad Asad, Muhammad Fayyaz, Anjum Munir*, Atiq-ur-Rehman Rattu
Crop Diseases Research Institute, Department of Plants and Environmental Protection, National Agricultural Research Center, Islamabad, Pakistan.

A B S T R A C T

The powdery mildew of wheat is considered to be of economic importance. During the era of 80's and early 90's the prevalence of powdery mildew was a regular feature in the wheat fields. Then the disease disappears and its prevalence became limited to few fields. However in the early 2000 the disease again showed its prevalence regularly wherever the wheat is cultivated in the country in diversified ecologies of Pakistan. Ninety two commercial wheat varieties were planted at Summer Agricultural Research Station, Kaghan with the objective to ascertain the resistant germplasm against Powdery mildew. The Kaghan Station is considered as a severe epidemic site and the hot spot for powdery mildew under natural field conditions. The universally susceptible wheat variety Morocco was included as a check which showed 100% disease infestation. Among the 92 varieties, 2 varieties were found resistant; 2 moderately resistant, 11 moderately susceptible, 29 susceptible and 48 highly susceptible.

Keywords: Wheat commercial varieties, screening, powdery mildew, SARS, Kaghan.

INTRODUCTION

Wheat is one of the most economically important food crops, which serves as a staple food for about 40% of the world's population. Of the cereal crops, wheat accounts for the greatest volume of international trade (Wiese, 1987). The major biotic stresses in Pakistan for sustainable wheat production include the three rusts and karnal bunt with barley yellow dwarf, some spot blotch, powdery mildew, aphids, smuts being of lesser concern but important for food security. (Mujeeb-Kazi and Kimber, 1985). The powdery mildew of wheat is considered to be of economic importance. During the era of 80's and early 90's the prevalence of powdery mildew was regular feature in the wheat fields. Then the disease disappears and its prevalence became limited to few fields. However in the early 2000 the disease again showed its prevalence regularly wherever the wheat is cultivated in the country in diversified ecologies (Rattu *et al*., 2009). Powdery mildew is an endemic disease widespread in many parts of the world and has been recognized as an important and devastating disease problem worldwide on wheat as well as other cereals and grasses for centuries (Bennett, 1984). This is a foliar disease caused by the filamentous ascomycete, *Erysiphe graminis* DC. f. sp. *tritici* Marchal (syn. *Blumeria graminis* f. sp. *tritici*) (anamorph: *Oidium monilioides* (Nees) Link), an obligate biotrophic fungus of the order Erysiphales which seldom kills its host (Forsstrom, 2002). The fungus is host-specific and is classified based on the host it affects. Multiple races of the fungus exist and new ones continue to be formed as a result of mutation and genetic recombination.

Yield losses associated with powdery mildew may be as high as 40% and are most severe when infection occurs prior to or at flowering and the flag leaf becomes infected (Royse *et al*., 1980). Yield reduction is related to reduction of grain size and number per unit area, although the components that are affected may be influenced by the wheat genotype (Bowen *et al*., 1991; Dickson, 1956). Powdery mildew typically does not result in serious yield reductions if it remains restricted

* Corresponding Author:
Email: anjums41@yahoo.com

to the lower canopy. However, it can reduce yield and test weight when infections occur on the flag leaves and heads (De Wolf and Phillip, 2007). The pathogen is considered highly nomadic due to the annual nature of the host, a requirement for green tissue throughout most of the year and the high wind dispersal. Thus wind is the main weather factor that increases the probability of occurrence of a powdery mildew epidemic, while temperature and humidity have the largest impact on the severity of an epidemic (Te Beest *et al*., 2008). Its populations can move on favorable winds at a rate of 100 km/year. The spores can move throughout the canopy with a velocity of 1.2 cm/sec, even in still air (Limpert *et al*., 1999).

A powdery mildew epidemic consists of a complex sequence of biological events taking place in a certain order in defined environments and is affected by temperature, moisture and nutrient availability. To successfully implement disease control it is necessary to interrupt the disease cycle so that the time for completing a cycle is extended. The infections conditions include host phenology and susceptibility and disease-conductive environment (Jarvis *et al*., 2002). It is common in wheat growing areas with a humid or semi-arid environment and favored by cool, damp weather with temperatures between 15 ^{o}C-18 ^{o}C and 75-100% relative humidity being optimum conditions that are common in late spring and early fall. Temperatures above 25 ^{o}C can severely retard the growth of mildew, which causes disease progression to slow as the growing season progresses into the hotter months (Leath and Bowen, 1989). Due to the airborne nature of the disease and the pathogen being obligate parasite it is difficult to control and the ultimate mean of management is breeding for the resistance. The screening under the control conditions needs very sensitive conditions to create epidemics. The ultimate alternative is to screen the material at the place where the disease under the natural field conditions occurs in epidemic. The Kaghan Station has been identified as the hot spot for the natural occurrence of Powdery mildew of wheat. The present study is conducted to evaluate the different wheat genotypes for the exploration of the resistance stock.

MATERIALS AND METHODS

Ninety two commercial wheat varieties were planted at Kaghan Station with the objective to evaluate against Powdery mildew for the identification of resistant sources. The Kaghan Station is considered to be the hot spot for powdery mildew and the conditions are the most suitable for the disease development under the natural field conditions. The universally susceptible wheat variety Morocco was included as a check which exhibited 100% disease infestation.

The material composed of genetic stocks was checked for powdery mildew resistance (for adult resistance). Disease evaluations were based upon foliar infection. The germplasm was subjected to powdery mildew screening under natural field conditions in Kaghan. For the evaluation of adult plant resistance, the test materials were field planted at Kaghan in 2 m rows and exposed to inoculum which was present naturally in abundance. The test materials were scored for resistance / susceptibility. The field planting was in single rows and unreplicated for resistant germplasm selection.

Disease Scoring: Disease evaluations were based upon foliar infection The scale used is a modified version of Saari and Prescot (1975) for foliar diseases (Eyal *et al*., 1987; Neupane *et al*., 2007). A double digit (D1D2) scale measured foliar infection was used, where the first digit equated to the height and the second digit with infection severity. The scale gradations were 0 to 9. For the height of infection a score of 5 was for plants with infection up to the plant center and a score of 9 the infection had spread to the flag leaf.

Powdery mildew on leaves

Powdery mildew on Spike

A disease severity score of 1 was for infected leaves exhibiting low disease symptoms whereas a 9 score reflected total destruction. The disease severity has been calculated by using the formula: % severity= (D1/9xD2/9) x100.

Whereas the reaction of the severity is categorized as follows:

1-10% =R, 11-30% =MR, 31-50%= MS, 51%-60=S, 61% and above= HS

RESULTS AND DISCUSSION

A maximum disease was observed under field condition which is evident from the fact that the check variety showed 100% infection.

Among the 92 varieties, two varieties (Parwaz-94 and SH-2002) were found resistant. Whereas Fakhre-Sarhad and Ufaq were the two varieties exhibited moderate resistance**.** Wheat material was tested in France under natural epiphytic condition for the two seasons and found the screening methodology well conducted (Bougot *et al.*, 2006).

Eleven wheat varieties were moderately susceptible, 29 susceptible and 48 exhibited highly susceptible reaction (Table 1). The leading wheat Seher-06 was found highly susceptible. Apart from this the other leading varieties planted every year in the plains of Sind and Baluchistan like TD-1, Sarsabz, Kirin-95, SKD-1, NIA-Amber, NIA-Sunehri and Khirman, all these wheat varieties showed their ineffectiveness against powdery mildew which is indication of alarming situation as far as resistance against this disease is concern. The varieties like GA-2002, Chakwal-50 and NARC-2009 are rainfed varieties and popular in the rainfed areas due to high yield and can with stand in adverse condition are also found moderate susceptible to susceptible. Pirsbak-04, Pirsbak05, Pirsbak-08 and Tatara of KPK were also highly susceptible. In Punjab Seher-06, Lasani-08, AARI-2011, Inqilab-91 and Faisalbad-08 are the leading wheat varieties were also found highly susceptible to powdery mildew. Gerechter-Amita and VanSilfhout (1984) evaluated the material collected from different sources for resistance to powdery mildew in field nurseries in Israel and Netherland found a diversity of responses to powdery mildew infection, ranging from highly resistant to completely susceptible.

CONCLUSION

The results are a clear indication of a successful screening of the material at hot spot at the one hand and there were very few entries containing resistance against the disease which reflect a very narrow gene pool available in the stock bearing resistance against this disease. There is a dire need that these resistant sources should be incorporated in the leading wheat varieties against powdery mildew by using conventional and molecular approaches.

Table.1. Screening of wheat commercial varieties against Powdery mildew of wheat at Kaghan during 2012-13.

Varieties	Pedigree/Parentage	Scoring (DD)	Severity %	Reaction
Bakhtawar	JUP/BJYG//URES CM 67458-4Y-1M-3Y-1M-5Y-0B	78	69	HS
Blue silver	1154-388/NA/3/YT54/N10B/LR64 II 18427-0PAK	78	69	HS
Chakwal86	Fln/ACS//ANA SWM4578-56M-3Y-3M-0Y-0PAK	88	79	HS
Sindh-81	Norento x Mexipak	67	51	S
Zarghoon	CC-Inia/Tobari-C.fon/BB CM8237-G-1M-3Y-2M-4Y-0M	87	69	HS
Faisalabad83	FURY/KAL/BB CM37138-48Y-1M-5Y-1M-4V-5Y-0A-0PAK	87	69	HS
Faislabad85	MAYA/MON//KVZ/TRM CM44083-N-3Y-1M-1Y-1M-1Y-OB	78	69	HS
Inqilab91	WL-711/CROW'S'	67	51	S
Kaghan93	TTR/JUN CM59123-3M-1Y-2M-1Y-2M-2Y-0M-0PAK	67	51	S

Continue…

Kirin95	WL-711/CROW'S'	77	60	S
Kohinoor83	OREF1158/FDL/MFN/2*TIBA63/3/COC CM37987-I-1Y-5M-OY-0PAK	66	37	MS
LU-26	BLS/KHUSHAL	68	44	MS
Nowshera96		88	79	HS
Parwaz94	V5648/PRL'S' = V-87189	32	07	R
Pasban90	INIA66/A. DISTT//INIA66/3/GEN	67	51	S
Mexipak65	Pj62/GB55 II8156-?	86	59	S
Punjab96	SA 42 *2/4CC/INIA//BB/3/ INIA/HD832 Pb1352-B-4K-36A-0A	87	69	HS
Saraib-92	PH-HARI Junco"S CM33483-C-7M-1Y-0M	88	79	HS
Sarsabz	PI/FRND//MXP/3/PI/M20/70	88	79	HS
Shaheen94	MLT"S"	85	49	S
Shahkar95	WL 711//F3.71/TRM Pb 20371-20A-4A-0A-0K-0A	88	79	HS
Sought90	Pavon Mutant-3	87	69	S
Tandojam 83	BLUEJAYHS CM-5287-J-1J-2M-2Y-3M-0Y	77	60	S
SH-2002	INQ91/FINK'S'	32	07	R
Pak 81	KVZ//BUHO//KAL/BB CM33027-F-15M-500Y-0M-76B-OY-OPAK	77	60	S
Bahawalpur-97	MTI 'S' CM47634-1-2M-3Y-1M-2Y-1Y-1M-0Y	89	88	HS
MH-97	ATTILA = ND/VG9144/KAL/BB/3/YACO/4/VEE#5	88	76	HS
Kohistan95	V-1562//CHRC`S'/HORK/3/KUFRA-I/4/CARP`S'/BJY`S' Pb. 24883-B-1A.OA.	67	51	S
Rohtas 90	INIA F 66/ A.DISTCHUM//INIA66/3/GEN W.8461-R-0PAK(PAK)	89	88	HS
Abadgar 93	_	88	79	HS
Anmol-91	LIRA 'S' CM-43903-H-4Y-1M-1Y-3M-3Y-0B	87	69	HS
Bahawlapur-2000	AU/UP301//GLL/Sx/3/PEW 'S'/4/MAI 'S'/MAY A 'S'//PEW'S' CM.67245-C-2M-OY	77	60	S
Bahkhar-2002	P20102//PIMA/SKA/3/TTR 'S' /BOW PB-23826-D-1A-1A-1T-1T-0T	65	37	MS
Fakhre-Sarhad	PFAU"S"/SERI/BOW "S" CM85295-010-TOPY-2M-0Y-0M-3Y-0M	55	30	MR
Marvi-2000	CMH-77 A917/KPV-1600//RL-6010/6*SKA	78	69	HS
Mehran-89	VEERY 'S' CM38027-F-15M-500Y-0M-87B-0Y	87	69	HS
Soorab-96	-	99	100	HS
Tatara	JUP/ALO"S"//KLT"S"/3/VEE"S" M79510-024Y-2M-05Y-01M-1Y-0B	88	59	S
Takbeer	-	89	88	HS

Continue…

AS-2002	KHP/D31708//CM74A370/3/CIAN079/4/RL6043/*4NAC PBD 795-23A-1A-0A.	88	79	HS
Iqbal-2000	BURGUS/SORT 12-13//KAL/BB/3/PAK 81 PB 21912-11A-0A-0A-59A-0A-0A	89	88	HS
Watan 94	_	88	79	HS
Moomal2002	BUC 'S'/4/TZPP//TRN46/CN067/3/PRT FLAKE 56744-7Y-2Y-1M-0M	56	37	MS
Zarlashta	Ures"s" / Bow CM78108-1M-02Y-02M-22Y-3B-0Y	87	69	HS
GA-2002	DWL5023/SNB//SNB CM84986-H-1M-3M-2B-0M	89	88	HS
Wafaq-01	OPATA/RAYON//KAUZ CMBW 90Y3180-0TOPM-3Y-010M-010M-010Y-1M-015Y-0Y.	87	88	HS
Margalla-99	OPATA/BOW'S' CM 83398-2M-0Y-0M-5Y-0M	87	69	HS
Manthar-3	KAUZ//ALTAR 84/AOS CM11163-6M-20Y-10M-0M-0B	77	60	S
Saleem2000	CHAM-6//KITE/PGO ICW 93-0032-7F-0K-0F	87	69	HS
Khyber87	KVZ/TRM//PTM/ANA-CM 43930 CM 43903-H-4Y-1M-1Y-3M-2Y-0B	68	59	S
Pirsabak2004	KAUZ/STAR	89	88	HS
Pirsabak-2005	MUNIA/SHTO//AMSEL	65	37	MS
Punjnad-1	Pb85/NKT BR2194-12B-OB	77	60	S
Darawar-97	SASONO KOMUGI/NORIN//BOB'S' Pb18551-2B-1B-1B-2B-1B-OB	89	88	HS
Sehar-2006	CHIL/2*STAR/4/BOW/CROW//BUC/PVN	89	88	HS
Shafaq-2006	LU26/HD2179//2*INQ-91	88	79	HS
Sutluj-86	CMT/YR//MON CM43405-A-2Y-1M-5Y-5M-1Y-0B-0PAK	78	69	HS
Bhittai	VEE/TRAP#1//SOGHAT-90	66	44	MS
Chakwal-50	ATTILA/3/HUI/CARC//CHEN/CHTO/4/ATTILA CMW90M48601-0T-TOPY-16M-1Y-010M-010Y-1M-015Y-0Y	56	37	MS
Saussi	CHIL / ALD // PVN / Yecora-70	67	51	S
Lasani-08	LUAN/Koh-97	78	69	HS
Fareed-06	PTS/3/TOB/LFN//BB/4/BB/HD-832-5//ON/5/GV/ALD'S'//HPO'S' BR-3385-3B-1B-OB	86	59	S
Faisalabad-08	PBW-65/2*PASTOR	56	37	MS
Bathoor-08	PFAU/JUN//KAUZ CM96818-1-0Y-0M-0B-2Y-2Y-0M	56	37	MS
Rashkoh-2005	Cow"S"**/YACO//Cow"S" CRG873-5Y-010M-0Y	66	44	MS
Aas-2009	KHP/D31708//CM74A370/3/CIAN079/4/RL6043/*4NAC PBD 795-23A-1A-0A.	88	88	HS

Continue…

NARC-2009	INQALAB 91*2/TUKURU CGSS99B00015F-099Y-099M-099Y-099M-29Y-0B-0ID	88	88	HS
AARI-2011	SH-88/90A204//MH-97	78	69	HS
NIFA-Barsat09	FRET2 CGSS96Y00146T-099B-099Y-099B-16Y-0B-0SY	77	60	S
BARS-2009	PFAU/SERI//BOW CM85295-101TOPY-2M-0Y-0M-3Y-0M-0SY	56	37	MS
Daman-98	BOW"S"/3/CAR853/COC//VEE"S", CP02274-4C-0C-0Y-5M-ORES	78	69	HS
Dera-98	F12-71/COC//CNO79 CM76688-9Y-03M-02Y-2B-0Y	77	60	S
Nasir-2K	RAJ 1771 5RK-9RK-10RK	67	51	S
Raj	KAUZ* 2/TRAP//KAUZ CRG 742-6Y-010M-0Y	88	88	HS
Zam-04	KAUZ* 2/OPATA//KAUZ CRG 732-11Y-010M-0Y	78	69	HS
Gomal-08	ATTILA CM 85836-4Y-0M-0Y-14M-0Y-5M-0Y-1SJ-0Y-	77	60	S
Hashim-08	JUP/ALD'S'//KLT'S'/3/VEE'S'/6/BEZ//0APTOB/8156/4/ON/3/6*TH/KF//6* LEE/KF/5 ICW91-0321-2AP-0TS-1AP-2AP-0L-0AP	77	60	S
TD-1	H-68XMAISXNORTENO	78	69	HS
SKD-01	HD-2329 PAU-ACC-3079	88	88	HS
Imdad-01	CHIL/2*STAR CM112793-0TOPY-8M-020-010M-3Y-010M-10Y	78	69	HS
Pirsabak-2008	KAUZ/PASTOR CMSS03B00025S-48Y-010M-010Y-010M-4Y-0M	77	60	S
Jauhar-78	Nayab* (Fast neutran 600rads (Mutagensis)	76	51	S
NIA-Amber	VEE//5 'S'/SARA//SOGHAT90	78	69	HS
NIA-Sunehri	Cham4//URES/BOW 'S'	88	88	HS
KT-2000	GEN#WHETON SWMI11508-LAP-1AP-1AP-4AP-1AP-5AP-0AP	77	60	S
KT-2010	_	67	51	S
Khirman	ULC/PVN//TAN/3/BUC	88	88	HS
OBT034	_	78	69	HS
Ufaq	V.84133/V83150	54	24	MR
Janbaz	_	67	51	S
Ghaznvi	_	77	60	S
Morocco	Check	99	100	HS

REFERENCES

Bennett, F.G.A. 1984. Resistance to powdery mildew in wheat: A review of its use in agriculture and breeding programmes. Plant Pathol. 33: 279-300.

Bougot, Y.J., M.T. Lemoine. H. Pavoine, V. Guyomar'ch, H.Gautier, Muranty, and D. Barloy. 2006. Major QTL effect controlling resistance to powdery mildew in winter wheat at the adult plant stage. Plant Breed. 125 (6): 550–556.

Bowen, K.L., K.L. Everts and S. Leath. 1991. Reduction in yield of winter wheat in North Carolina due to powdery mildew and leaf rust. Phytopathol. 81:

503-511.

De Wolf, E.D. and E. Phillip. 2007. Wheat variety disease and insect ratings 2007. Kansas State University, USA.

Dickson, J.G. 1956. Diseases of field crops. McGraw Hill Book Company, New York, USA.

Eyal, Z, A.L. Scharen, J.M. Prescott, and M. Van Ginkle.1987. The Septoria Diseases of Wheat: concepts and Methods of Disease Management. Mexico, D.F: CIMMYT.

Forsstrom, P.O. 2002. Broadening of mildew resistance in wheat. Swedish University of Agricultural Sciences, Alnarp Sweden. pp. 7-54.

Gerechhter-Amita, Z.K. and C.H. Vansilfhout. 1984. Resistance to powdery mildew in wild emmer (*Triticum dicocciodes* KORN.). Euphytica 33(2): 273-280.

Jarvis, W.R., W.G. Gubler and G.G. Grove. 2002. Epidemiology of powdery mildew in agricultural pathosystems. *In*: The powdery mildews: A comprehensive treatise. (Eds. R. R. Belanger, W. R. A. J Bushnell,. Dick and T. L. W. Carver. The Am. Phytopath. Soc., St. Paul, Minnesota. pp. 169-199.

Leath, S. and K.L. Bowen. 1989. Effects of powdery mildew, Triadimenol seed treatment, and triadimefon foliar sprays on yield of winter wheat in North Carolina. Phytopathol. 79: 152-155.

Limpert, E.,F. Godet and K. Muller. 1999. Dispersal of cereal mildews across Europe. Agric. For. Meteorol. 97: 293-308.

Mujeeb-Kazi, A. and G. Kimber. 1985. The production, cytology and practicality of wide hybrids in the Triticeae. Cereal Res. Commun. 13: 111-124.

Neupane R.B., R.C. Sharma, E. Duveiller, G. Ortiz-Ferrara, B.R. Ojha, U.R. Rosyara, D. Bhandari, M.R. Bhatta. 2007. Major Gene Controls of Field Resistance to Spot Blotch in Wheat Genotypes Milan/Shanghai #7 and Chirya. 3. Plant Dis. 91:6, 692.

Rattu, A.R., S. Asad, and M. Fayyaz. 2009. Status of Foliar diseases in Punjab, Pakistan. Report, CDRP, IPEP, NARC, Islamabad.

Royse, D.J., L.V. Gregory, J.E. Ayers and H.Jr. Cole. 1980. Powdery mildew of wheat: Relation of yield components to disease severity. Can. J. Pl. Pathol. 2: 131-136.

Saari, E.E. and J.M. Prescott. 1975. A scale for appraising the foliar intensity of wheat diseases. Plant Dis. Reptr. 59:377-380.

Te Beest, D.E., N.D. Paveley, M.W. Shaw and F. van den Bosch. 2008. Disease-weather relationships for powdery mildew and yellow rust on wheat. Phytopathol. 98: 609-617.

Wiese, M.V., ed. 1987. Compendium of wheat diseases, 2nd ed. St Paul, MN, USA, APS Press.